

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF RESEARCH ADMINISTRATION

RESEARCH PROJECT INITIATION

Date: June 28, 1974

Project Title: **Reading Difficulty and Cross-Modal Integration**

Project No: **G-42-623**

Principal Investigator **Dr. M. Carr Payne, Jr./Dr. Richard K. Davenport**

Sponsor: **The Spencer Foundation; Chicago, Illinois**

Agreement Period: From July 1, 1974 Until June 30, 1976

Type Agreement: **Grant**

Amount: **\$55,750**
30,833 Cost-sharing (OH)
\$86,583 TOTAL

Reports Required: **Annual Report** **Both Technical & Fiscal**
Final Report

Sponsor Contact Person (s):

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The Spencer Foundation
875 North Michigan Ave.
Chicago, Illinois 60611

Assigned to: Psychology

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GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT TERMINATION

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Date: September 28, 1976

Project Title: Reading Difficulty and Cross-Modal Integration

Project No: G-42-623

Project Director: Dr. M. Carr Payne, Jr./Dr. Richard K. Davenport

Sponsor: The Spencer Foundation: Chicago, Illinois

Effective Termination Date: 9/30/76

Clearance of Accounting Charges: ASAP

Grant/Contract Closeout Actions Remaining:

- ☐ Final Invoice and Closing Documents
- ☒ Final Fiscal Report
- ☐ Final Report of Inventions
- ☐ Govt. Property Inventory & Related Certificate
- ☐ Classified Material Certificate
- ☐ Other _____

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PROGRESS REPORT

G-42-623

READING DIFFICULTY AND CROSS-MODAL INTEGRATION

July 1, 1974-June 30, 1975

M. Carr Payne, Jr.

Richard K. Davenport: Co-principal investigators

The purpose of this grant is to investigate the relationship between difficulties in reading and cross-modal perception, and, if such relationships are established, to develop a procedure for early detection of potential reading problems in young children.

The literature review prepared for the grant application has been extended, updated, and a summary paper on "A Perceptual Cognitive Approach to Reading and Reading Disability" prepared.

To extend availability of subject populations additional personal calls were made upon a number of school officials in the Metropolitan Atlanta area.

Data were gathered with 28 11-year old students, who were two years behind national norms on the reading comprehension test of the Iowa Tests of Basic Skills, to investigate accuracy of form perception. Three-dimensional forms were presented cross-modally or intra-modally in a match-to-sample procedure. No significant differences occurred between cross-modal and intra-modal presentation.

As projected in the original grant application, we collaborated with an electrical engineer to design and construct an apparatus which delivers a series of "dot-dash" patterns either visually, auditorially, or haptically. Because of delays in delivery of parts the apparatus was not available as soon as we had anticipated, thereby precluding initiation of data collection during the Spring school term. This apparatus is designed for use in experiments to investigate whether relationships reported in the literature between reading difficulty and cross-modal integration may not be due to the nature of the task itself (a temporal pattern task) rather than due to the cross-modal presentation.

In order to commence studies with the apparatus as early in the fall of 1975 as possible, we have examined test scores of third, fourth, and fifth grade students in the Atlanta public school system to identify experimental and control subjects. The criterion is 1.5 years behind grade-level on reading comprehension but at grade-level on vocabulary based on national norms for the Iowa Tests of Basic Skills. Forty experimental subjects have been identified at each grade level. One control group for the third grade subjects and two control groups for fourth and fifth grade subjects have been selected. One control group is composed of normal readers matched on age, sex, and vocabulary score. The other is matched on sex and reading comprehension score.

Test scores on the Iowa Tests of Basic Skills serve as the criterion for reading difficulty in our studies. To take this test a student must read instructions. It is possible that a student who has difficulty in reading may be penalized in his test score by a test in which instructions are written. To examine this possibility, we administered (with permission of the test publisher) items from the vocabulary test of the Iowa Tests of Basic Skills to 20 sixth-grade children who were identified by the school system as slow readers (at least 1.5 years behind national norms). Instructions were entirely oral. Items were administered in both oral and written form. Subjects performed significantly better on items which were presented orally.

Preliminary work with the experimental apparatus is planned for the summer. This will allow us to commence testing in the fall soon after schools open.

EXPENDITURES

July 1, 1974-June 30, 1975

Personal Services:

Drs. Davenport & Payne	\$8,381.88	
Graduate Assistants	5,600.00	
		\$13,981.86
Retirement		609.08
Materials and Supplies		1,347.92
Capital Outlay		150.00
Total Expended		\$16,088.86

FINAL REPORT

READING DIFFICULTY AND CROSS-MODAL INTEGRATION

July 1, 1974 - September 30, 1976

M. Carr Payne, Jr.

Richard K. Davenport: Co-principal investigators

James G. Domangue, Jr.

Richard D. Soroka: Graduate assistants

Audrey Fullerton: Summer 1976 Graduate assistant

The objective of this research was to test the hypothesis that difficulties in reading are related to abilities in cross-modal perception. Specific aims stated in our proposal were:

1. To compare cross-modal integrative abilities of children from 8 to 10 years of age who have been identified by the school as having reading difficulties with those of a control group.
2. To compare abilities in cross-modal perception with performance on reading tests.
3. To investigate feasibility of using cross-modal procedures as an early detection device for potentially poor readers if results of 1 and 2 show that students who have reading problems differ from children

in the control group in their abilities
in cross-modal perception.

Progress made under the grant will be described in terms
of these aims.

Literature Review.

Literature about cross-modal perception, both as a phenomenon per se and as it relates to reading, has been systematically and continually reviewed throughout the period of the grant. A review paper, "A Perceptual Cognitive Approach to Reading and Reading Disability," was prepared. This is being continually up-dated.

Studies Completed.

1. Ability to recognize three-dimensional forms cross-modally (vision and touch) or intra-modally was measured by a match-to-sample technique in twenty-eight, eleven year old students, who were two years behind national norms on the Reading Comprehension Test of the Iowa Tests of Basic Skills. No significant differences in accuracy were found between cross-modal and intra-modal presentations. Because these data did not show cross-modal vs. intra-modal differences in poor readers, no further experiments were conducted on form perception. However, this study did serve to train the graduate assistants

in gathering data from children and familiarize them with a match-to-sample procedure.

2. Literature review shows that the criterion for reading used in studies of cross-modal perception as related to reading performance was scores on a standardized test. In the Atlanta Public School System the Iowa Tests of Basic Skills is routinely administered as an achievement and diagnostic instrument. Instructions are given by a classroom teacher to the students who must also read them. It is possible that a student who has difficulty in reading may be penalized in his/her test score by a test in which instructions are written. To examine this possibility we administered (with permission of the test publisher) items from the Vocabulary Test of the Iowa Tests of Basic Skills to 20 sixth-grade children (14 boys and 6 girls) who had taken the test previously and who were at least 1.5 years behind national norms. General instructions were entirely oral. Sixteen items each were administered in oral and written form. Subjects performed significantly better on items which were presented orally, although performance was poor under both conditions. Six students of a control group who are matched to the above children on age and sex but whose test scores are at grade level have been tested. There was no significant difference between oral and written presentation in this group. Data will be gathered from fourteen more students

in the control group after conclusion of the grant (i.e. after school is open) and a final report, which has already been started, prepared for publication. In addition to comparing written and verbal means of giving instructions this study suggests the importance of instructions to obtaining valid measures of an individual's abilities. We have found little research in the literature related to these points.

3. A rugged, portable apparatus was designed and constructed for this grant by an engineer at the Georgia Tech Engineering Experiment Station. The apparatus served so well that no data was lost because of equipment malfunction. This apparatus delivers a series of "dot-dash" patterns either visually (light-flash), auditorially (tone), or tactually (vibration). The apparatus presents two patterns made up of combinations of "dots," "dashes," and spaces. Duration of these may be varied, but a "dash" is always three times as long as a "dot." Any single pattern may be presented visually, auditorially, or tactually. A subject must recognize whether the two patterns are the same or different, regardless of the modality in which each pattern appears; for example, if the first and second patterns both were presented visually the condition would be described as visual-visual (VV) or if the first pattern was presented auditorially and the second tactually the condition would be described as auditory-tactual (AT). The

person being tested indicates a judgment by pressing one of two lighted response buttons depending on whether he/she perceives the two patterns as the same or different. Number of correct judgments is automatically registered.

4. Twenty-nine clients of the Emory University Reading Center were studied using the apparatus. These people ranged in chronological age from seven to 17 years. In a single session each person made 12 same-different judgments under each of four conditions--auditory-auditory, visual-visual, auditory-visual and visual-auditory. Four of these judgments were of three-element patterns, four of four-element patterns, and four of five-element patterns. Performance on these tasks is being compared with scores on standardized tests in the client's dossier. Although the number of people is small, this comparison may be important, as scores on these tests are not available in a sample of students drawn from the Atlanta Public School System. In addition, children in this sample have been tested with a more complete diagnostic battery and more information is available about them. It is planned to continue working with clients of the Emory University Reading Center after termination of the grant.

5. In order to obtain a better understanding of perception of temporally organized stimuli, both cross-modally and intra-modally, and to insure that our patterns, instructions,

and procedure were truly appropriate we conducted an experiment with 90 college age students. This experiment showed that performance did not vary with the number of elements (three, four or five) in a stimulus pattern. Performance was significantly better when judgments were made intra-modally rather than cross-modally. Auditory-auditory (AA) and auditory-visual (AV) judgments were significantly better than visual-auditory (VA) or tactual-visual (TV). An important finding was that performance due to modality of the first pattern in a pair was significantly different among modalities while that due to modality of the second pattern was not. This result was due to superior performance when the first pattern was presented auditorially. An article based upon this study has been prepared which is ready for submission for publication.

6. We conducted an extensive study with children in the fourth, fifth, and sixth grades of the Atlanta Public School System. At the suggestion of officials of the School System we studied children whose chronological age range is from 8 to 12 years, rather than children in the chronological age ranges of 8 to 10 years as originally included in the proposal. Numbers of children who are having difficulty in reading are identified by the System at the ages of 3rd or 4th grade children and older, but identification is more uncertain for age groups younger than these.

Students were identified on the basis of records in the Central Office of the Atlanta Public School System. Each student was then located within the System. Permission for participation was received from the principal and the students' parents. Data were then gathered individually from each student at his/her own school. Thus, students who participated in the study came from over 20 different schools.

Students were assigned to groups on the basis of age, school grade, and scores on the Iowa Tests of Basic Skills which is administered yearly to all students in the Atlanta Public School System. Scores from the tests administered in Spring 1974 were used. A student was assigned to the Poor Reader Group (PR) if his/her grade placement on the Reading Comprehensive Test was at least 1.5 years below average for his/her grade level and his/her score on the Vocabulary Test was average. For each student assigned to the Poor Reader Group two students were matched and assigned to control groups. Each student in Control Group 1 (C1) was matched to a student in the Poor Reader Group on the basis of age (within three months), sex, and Vocabulary grade placement (within four months) but with Reading Comprehension at least 1.5 years above that of the student in the Poor Reader Group. Each student in Control Group 2 (C2) was matched to a student in the Poor Reader Group on the basis of sex and Reading Comprehension

grade placement (within two months). These C2 students were attending school at a grade level two years lower than their corresponding Poor Reader students. This procedure provided three groups of students at each grade except that there was no C2 group corresponding to the fourth grade level, as students of these ages were not in school when the Iowa Tests of Basic Skills were administered to the Poor Reader and C1 groups.

One hundred eighty-three students were tested--37 fourth graders, 72 fifth-graders, and 74 sixth-graders. In order to have equal numbers of students in the Poor Reader and Control Groups in each school grade, data was analyzed for 157 students. Table 1 describes characteristics of students whose data was included in the analysis.

Place Table 1 about here

In the study each student was tested with the same patterns as were used in Study 5 above. For a given student the second pattern of a pair was always presented in a single modality, either auditorially, visually or tactually. Patterns were presented in three blocks. For one block the first pattern was presented auditorially, for another visually, and for a third, tactually. There were 12 trials in each block. Prior to each block the student was trained on the modality combination associated with that block (e.g., VA, VV) until he/she

reached a criterion of three successive correct responses. In terms of experimental design, modality of the first pattern was presented within subjects while modality of the second pattern was presented across subjects. The student's task was to determine whether two sequentially presented temporal dot-dash patterns were identical or different.

Because of the absence of the C2 group for the fourth-grade students, two analyses were conducted by an analysis of variance. One analysis was carried out on data from all three grades, but only for the Experimental and C1 groups (N=116). Another was carried out using data from the fifth and sixth grades only, but using data from all three groups (E, C1, C2) (N=123). Results of these two analyses were consistent. Dunn's Multiple Comparisons test was used for more specific analysis of significant interactions. One-tailed t-tests were used to analyze difference between the Experimental Group and C1 Group for each combination of modalities (e.g., VA, TT, etc.). Pearson product moment correlations were calculated between performance as a function of the first modality and both Reading Comprehension and Vocabulary scores on the Iowa Tests of Basic Skills.

Results clearly show that scores on the experimental task are related to reading difficulty, as the Poor Reader group did not perform as well as either control group. Sixth grade stu-

dents did better than fifth grade students, who in turn did better than fourth grade students. As in Study 4, performance due to the modality of the first pattern of a pair was significant. If the first pattern was presented auditorially, performance was superior as compared to conditions in which it was presented visually or tactually. If it was presented tactually, performance was better than if it was presented visually. Correlations between performance as a function of the first modality in a pattern and scores on the Reading Comprehension Test were much higher than correlations between performance as a function of the first modality and scores on the Vocabulary Test.

When patterns were presented intra-modally, performance was better than when patterns were presented cross-modally. Performance under an auditory-auditory (AA) condition was superior to performance under any other condition.

When performance of the Poor Reader and Cl groups was compared, only auditory-auditory of the intra-modal conditions discriminated significantly. Considering data for all three grades together, any comparison in which the first pattern was presented auditorially, discriminated consistently, while comparisons involving the other two modalities did not. This indicates that cross-modal perception does not account for the differences between students classified as poor in Reading Comprehension and

other students, but that ability to recognize an auditorially presented, temporally organized pattern, does.

A draft of a paper reporting this study is in preparation.

7. To be sure that the apparatus and procedure utilized in studies 5 and 6 are suitable for younger children, data were gathered using audition as the first modality, and each of the modalities (audition, vision and touch), as the second modality, from four-year old, five-year old and six-year old children. Each child was trained until he/she reached a criterion of five successive correct trials on a given condition (e.g., AV), before he/she was tested under the condition. Training and testing were completed for a given condition before the procedure was repeated for the next condition. Patterns used with these children were simpler than those used in the other studies. Only "dots" and "dashes" were used as elements (constant spaces). Each pattern contained only three or four elements. This study demonstrated that with these simpler patterns, the procedure used with fourth, fifth, and sixth grade children and college students was suitable with children of these ages. The apparatus and procedure employed show promise as an early detection device.

Papers Reported.

Papers based on research conducted on the grant were presented at the following professional meetings:

Southern Society for Philosophy and Psychology
Atlanta, GA April 16, 1976

American Psychological Association
Washington, DC September 6, 1976

Dr. Payne presented a seminar at the Department of Experimental Psychology, Oxford University, England, on "Cross-modal Perception and Reading Difficulty," June 25, 1976.

An abstract of Study 6, which was conducted in the Atlanta schools, was prepared and sent to each principal and public school official who helped us obtain students for that study. A copy of this abstract is enclosed in the appendix.

Other Results From the Grant.

This grant had several intangible effects. It enabled the investigators to have time to think and reflect, which is fundamental to advances in science and education. All the participants had the opportunity to become more knowledgeable about problems in reading, and to exchange ideas with specialists from other fields as well as psychologists. Discussions with people from Education and the School System, in particular, were invaluable to progress in the studies undertaken.

Travel funds from the grant were used to visit laboratories and scholars in England, where interest in the pure and applied aspects of reading is especially high. These visits not only informed us about related research, but also introduced

us to literature which helped with interpretation of our own data, and helped in generation of new ideas for research. Although some of the English research has been reported in this country, much of it is not particularly well known here.

Graduate students who worked on the grant developed active interests in this area of research. None of them had gathered data or worked with young children before. The support by the grant gave them the opportunity to obtain extensive experience with children from a variety of backgrounds. Mr. Domangue is currently working on a Ph.D. dissertation which is a continuation of ideas he obtained while working on the grant. Mr. Soroka is planning to do his dissertation research on a problem involving young children. Mrs. Fullerton has had but one year of graduate training in Psychology, but was particularly interested in getting experience with young children which summer work on the grant provided.

In brief, research carried out under this grant has shown that performance of fourth, fifth, and sixth grade children on a temporally organized task is related to scores on a Reading Comprehension Test. This is due to performance in the auditory modality and not to differences in intra-modal and cross-modal presentations. A modification of the task can readily be done by four- and five-year old pre-school children. Since these tasks do not require paper and pencil, are relatively language

free, and measure something apart from vocabulary, results of the research made possible by the Spencer Foundation show promise for early identification of some children who are likely to have difficulty learning to read.

In addition, Foundation support has encouraged the investigators to pursue further work in reading and in the basic underlying perceptual processes. New research ideas have been generated which will be explored in the upcoming years.

ABSTRACT

READING DIFFICULTY AND CROSS-MODAL INTEGRATION

M. Carr Payne, Jr.

Richard K. Davenport: Co-principal investigators

James G. Domangue, Jr.

Richard Soroka: Graduate assistants

The suggestion has been made that children who find it difficult to recognize something presented to one sense as the same thing when it is presented to another sense (poor cross-modal integration), may have difficulty learning to read. Since reading involves patterning (for example, a sentence, omitting its words, might fit a pattern such as da,da da,da da,da), we wished to see if there is a relationship between cross-modal integration and difficulty in reading, using "dot-dash"-type patterns which are organized in time (i.e., temporal patterns). Our apparatus presents two "dot-dash" patterns in sequence. The child must recognize whether the patterns are the same or different, and indicate the choice by pressing the appropriate button. Each pattern can be presented to hearing, vision or touch.

Three groups of students participated. A student was assigned to Group E if his/her score on the Reading Comprehension test of the Iowa Tests of Basic Skills was at least 1.5 years below average for his/her grade level and his/her score on the

Vocabulary test was average. Each student assigned to Group C1 was matched to a student in Group E, on the basis of age, sex, and Vocabulary, but Reading Comprehension was at least 1.5 years above that of the student in Group E. Each student assigned to Group C2 was matched to a student in Group E, on the basis of sex and Reading Comprehension grade placement. Students were from the fourth, fifth and sixth grades. When a Graduate assistant tested an individual student he did not know to which group the student belonged.

Each student made 36 same-different judgments. For a single student, the second pattern of a pair was always presented to a single sense, but the first pattern was presented to vision, hearing, and touch, for 12 judgments each. For one-third of the students, the second pattern was presented to vision; for another third to hearing, and for a third, to touch.

Group E did not perform as well as Groups C1 or C2. This shows that scores on the task are related to reading, as the groups were selected on the basis of Reading test scores. Regardless of group, sixth grade children made better scores than fifth grade children, who in turn, did better than fourth grade children.

If both patterns were presented to the same/sense (intramodally), scores were better than if they were presented to different senses (cross-modally). When both patterns were

presented to hearing, performance was best.

When Groups E and C1 were compared, any comparison in which the first pattern was presented to hearing showed a difference between the groups, while comparisons involving the other senses, did not. This suggests that cross-modal perception does not account for the differences between students classified as poor in Reading Comprehension, and other students, but that ability to recognize a pattern presented to hearing, does.

This study indicates that performance of fourth, fifth, and sixth grade children on a pattern task is related to scores on a Reading Comprehension test. This is due to performance in the hearing sense (not how well you can hear), and not to differences in intra-modal and cross-modal presentation. Later work has shown that pre-school age children can readily do the task. Since the task does not require paper and pencil, is relatively language free, and measures something apart from vocabulary, results of this research show promise of early identification of some children who are likely to have difficulty learning to read.

TABLE 1

MATCHED GROUPS
(Equal N's)

School Grade	Second Sensory Modality	Condition	Mean Age	Mean Vocabulary	Mean Comprehension
4	Auditory N = 5	PR	10/00	3/0	1/3
		C	10/03	3/0	3/5
	Visual N = 5	PR	10/02	3/0	1/3
		C	9/10	3/3	3/3
	Tactual N = 7	PR	10/00	3/0	1/5
		C	9/11	2/9	3/3
5	Auditory N = 7	PR	11/00	3/9	2/1
		C1	10/10	4/0	4/1
		C2	8/04	1/9	2/2
	Visual N = 8	PR	11/00	4/2	2/2
		C1	11/00	4/0	4/1
		C2	9/00	1/9	2/2
	Tactual N = 6	PR	10/11	3/8	2/1
		C1	10/10	3/7	4/2
		C2	8/10	2/0	2/0
6	Auditory N = 6	PR	11/11	4/2	2/6
		C1	11/10	4/3	5/2
		C2	9/09	3/1	2/8
	Visual N = 6	PR	11/08	4/8	2/7
		C1	11/10	4/8	5/1
		C2	9/11	3/2	2/7
	Tactual N = 8	PR	11/08	4/5	2/8
		C1	11/10	4/7	4/7
		C2	9/08	3/2	2/7

EXPENDITURES

	July 1, 1974- June 30, 1975	July 1, 1975- Sept. 30, 1976	Total
Personal Services			
Drs. Davenport & Payne	\$8,381.88	\$24,476.88	\$32,858.76
Graduate Assistants	5,600.00	8,398.98	13,998.98
Typist		1,073.28	1,073.28
Total			\$47,931.28
Retirement	609.08	2,071.88	2,680.96
Materials and Supplies	1,347.92	1,815.02*	3,162.94
Capital Outlay	150.00	224.03*	374.03
Travel		1,600.00	1,600.00
Grand Total			\$55,748.95

*Including encumbrances